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PATENT

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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re application of: Ghaemmaghami et al.
Serial No.: 09/497,320 Art Unit: 2815
Filed: February 3, 2000 Examiner: Jose R. Diaz
For: METHOD AND SYSTEM FOR PROVIDING HALO IMPLANT TO A SEMICONDUCTOR DEVICE WITH MINIMAL IMPACT TO THE JUNCTION CAPACITANCE

Mail Stop Appeal Brief-Patents
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

TRANSMITTAL OF APPEAL BRIEF
(PATENT APPLICATION - 37 CFR 1.192)

1. Transmitted herewith in triplicate is the APPEAL BRIEF in this application with respect to the Notice of Appeal filed on June 15, 2004.

NOTE: "The appellant shall, within 2 months from the date of the notice of appeal under § 1.191 in an application, reissue application, or patent under reexamination, or within the time allowed for response to the action appealed from, if such time is later, file a brief in triplicate." 37 CFR 1.192(a) (emphasis added).

2. STATUS OF APPLICANT

This application is on behalf of

- ☒ other than a small entity
- ☐ small entity
  - verified statement:
  - ☐ attached
  - ☐ already filed

3. FEE FOR FILING APPEAL BRIEF

Pursuant to 37 CFR 1.17(f) the fee for filing the Appeal Brief is:

☐ small entity	$165.00
☒ other than a small entity	$330.00
Appeal Brief fee due	**$330.00**

CERTIFICATE OF MAILING (37 CFR § 1.8)

I hereby certify that this paper (along with any paper referred to as being attached or enclosed) is being deposited with the United States Postal Service on the date shown below with sufficient postage as first class mail in an envelope addressed to Mail Stop Appeal Brief-Patents, Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.

30

Date: 8/9/04

Serena Beller
(Type or print name of person mailing paper)

Serena Beller
(Signature of person mailing paper)

4. EXTENSION OF TERM

NOTE: The time periods set forth in 37 CFR 1.192(a) are subject to the provision of § 1.136 for patent applications. 37 CFR 1.191(d). Also see Notice of November 5, 1985 (1060 O.G. 27).

The proceedings herein are for a patent application and the provisions of 37 CFR 1.136 apply.

(complete (a) or (b) as applicable)

(a) ☐ Applicants petition for an extension of time under 37 CFR 1.136 (fees: 37 CFR 1.17(a)-(d)) for the total number of months checked below:

Extension (months)	Fee for other than small entity	Fee for small entity
☐ one month	$ 110.00	$ 55.00
☐ two months	$ 420.00	$ 210.00
☐ three months	$ 950.00	$ 475.00
☐ four months	$ 1,480.00	$ 740.00
Fee		

If an additional extension of time is required, please consider this a petition therefor.

(check and complete the next item, if applicable)

☐ An extension for _________ months has already been secured and the fee paid therefor of $_________ is deducted from the total fee due for the total months of extension now requested.

Extension fee due with this request $_______________

or

(b) ☒ Applicants believe that no extension of term is required. However, this conditional petition is being made to provide for the possibility that applicants have inadvertently overlooked the need for a petition and fee for extension of time.

5. TOTAL FEE DUE

The total fee due is:

Appeal Brief fee $330.00

Extension fee (if any) $0

TOTAL FEE DUE $330.00

6. FEE PAYMENT

☐ Attached is a check in the sum of $_____

☒ Charge Account No. 01-0365 (E0545) the sum of $330.00.

A duplicate of this transmittal is attached.

7. FEE DEFICIENCY

NOTE: If there is a fee deficiency and there is no authorization to charge an account, additional fees are necessary to cover the additional time consumed in making up the original deficiency. If the maximum, six-month period has expired before the deficiency is noted and corrected, the application is held abandoned. In those instances where authorization to charge is included, processing delays are encountered in returning the papers to the PTO Finance Branch in order to apply these charges prior to action on the cases. Authorization to charge the deposit account for any fee deficiency should be checked. See the Notice of April 7, 1986, 1065 O.G. 31-33.

☒ If any additional extension and/or fee is required, this is a request therefor and to charge Account No. 01-0365 (E0545).

AND/OR

☒ If any additional fee for claims is required, charge Account No. 01-0365 (E0545).

Reg. No.: 47,159

SIGNATURE OF ATTORNEY

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BEFORE THE BOARD OF PATENT APPEALS AND INTERFERENCES

In re Application of: Ghaemmaghami et al.

Serial No.: 09/497,320

Filed: February 3, 2000

Group Art Unit: 2815

Before the Examiner: Jose R. Diaz

Title: METHOD AND SYSTEM FOR PROVIDING HALO IMPLANT TO A SEMICONDUCTOR DEVICE WITH MINIMAL IMPACT TO THE JUNCTION CAPACITANCE

APPEAL BRIEF

Mail Stop Appeal Brief-Patents
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P.O. Box 1450
Alexandria, VA 22313-1450

I. REAL PARTY IN INTEREST

The real party in interest is Advanced Micro Devices, Inc., which is the assignee of the entire right, title and interest in the above-identified patent application.

CERTIFICATION UNDER 37 C.F.R. § 1.8

I hereby certify that this correspondence is being deposited with the United States Postal Service with sufficient postage as first class mail in an envelope addressed to Mail Stop Appeal Brief-Patents, Commissioner for Patents, P.O. Box 1450, Alexandria, Virginia 22313-1450, on August 9, 2004.

Serena Beller
Signature

Serena Beller
(Printed name of person certifying)

II. RELATED APPEALS AND INTERFERENCES

There are no other appeals or interferences known to Appellants, Appellants' legal representative or assignee which will directly affect or be directly affected by or have a bearing on the Board's decision in the pending appeal.

III. STATUS OF CLAIMS

Claims 1, 4, 5, 7, 8, 11, 12 and 14-20 are pending in the Application. Claims 15-17 are allowed. Claims 1, 4, 5, 7, 8, 11, 12, 14 and 18-20 stand rejected.

IV. STATUS OF AMENDMENTS

The Appellants' response to the Office Action, having a mailing date of November 17, 2003, has been considered, but the Examiner indicated that it did not place claims 1, 4, 5, 7, 8, 11, 12, 14 and 18-20 in condition for allowance because the Appellants' arguments were deemed unpersuasive.

V. SUMMARY OF INVENTION

A halo implant is typically utilized to implant dopant on a semiconductor device. Specification, Page 1, Line 6. In-line lithography or DUV (deep ultra violet) photoresist is typically utilized to mask the halo implant process. Specification, Page 1, Lines 6-8. Typically, the same mask (lightly doped drain) (LDD) is utilized for the halo implant, since the halo implant takes place after the LDD implant. Specification, Page 1, Lines 8-9. Due to the chemistry of the photoresist, an implant shadowing problem may occur which adversely affects yield and performance of the devices as manufacturing processes move toward smaller geometries. Specification, Page 1, Lines 9-12.

The first problem is that the photoresist thickness in the area of implant is of a thickness such that an implant delivered at a 45° angle can result in an asymmetric and leaky transistor. Specification, Page 1, Lines 13-15. A second problem is the thickness of the photoresist related to the trench oxidation region of the device. Specification, Page 1, Lines 15-16. If a thick photoresist (0.55μm or greater) is placed over the trench oxidation, oftentimes the photoresist will fall and cover areas that are to be implanted. Specification, Page 1, Lines 16-18. Even if the photoresist stands erect at the smaller process technologies, the halo implant will not reach the targeted areas. Specification, Page 1, Lines 18-19. In addition, the conventional processes do not typically account for the need for selective doping of the source/drain area. Specification, Page 1, Lines 19-21.

Accordingly, what is needed is a system and method for overcoming the above-identified problems at smaller process geometrics. Specification, Page 2, Lines 1-2.

The problems outlined above may at least in part be solved in some embodiments by providing a thin photoresist layer to the semiconductor device. Specification, Page 2, Lines 7-8. A halo implant may be provided to the appropriate area of the semiconductor device. Specification, Page 2, Lines 8-9.

Accordingly, a photoresist that is capable of a thinner profile is utilized. Specification, Page 2, Lines 10-11. This may allow one to lower the photoresist thickness to a proposed 1000Å (in the field) or lower if the process allows. Specification, Page 2, Lines 11-13. With this photoresist thickness, taking into account other height variables, the source and drain regions may be opened only as needed. Specification, Page 2, Lines 13-14.

At a 45° angle, the implant may be delivered to all transistors in the circuit in the targeted areas as well as getting only a large amount of the dose (up to ¾ of the

dose) to the transistor edge which sits on the trench edge. Specification, Page 2, Lines 15-17. This may also minimize the counter doping of the source/drain with the opposite species as is required by the definition of the halo process. Specification, Page 2, Lines 17-18.

VI. ISSUE

A. Are claims 1, 4-5, 8 and 11-12 properly rejected under 35 U.S.C. §103(a) as being unpatentable over Hori et al. (U.S. Patent No. 5,320,974) (hereinafter "Hori") in view of Wolf et al. ("Silicon Processing for the VLSI Era, Volume 1: Process Technology", Lattice Press, 1986, pp. 321-324) (hereinafter "Wolf")?

B. Are claims 7 and 14 properly rejected under 35 U.S.C. §103(a) as being unpatentable over Hori in view of Wolf and in further view of Thackeray et al. (U.S. Patent No. 6,037,107) (hereinafter "Thackeray")?

C. Are claims 18 and 19 properly rejected under 35 U.S.C. §103(a) as being unpatentable over Rodder (European Patent No. EP 0 899 793 A2) (hereinafter "Rodder")?

D. Is claim 20 properly rejected under 35 U.S.C. §103(a) as being unpatentable over Rodder in view of Thackeray?

VII. GROUPING OF CLAIMS

Claims 1, 4-5, 8 and 11-12 form a first group.

Claims 7 and 14 form a second group.

Claims 18, 19 and 20 should not be grouped together and should be considered separately.

The reasons for these groupings are set forth in Appellants' arguments in Section VIII.

VIII. ARGUMENT

A. Claims 1, 4-5, 8 and 11-12 are not properly rejected under 35 U.S.C. §103(a) as being unpatentable over Hori in view of Wolf.

The Examiner has rejected claims 1, 4-5, 8 and 11-12 under 35 U.S.C. §103(a) as being unpatentable over Hori in view of Wolf. Paper No. 28, page 2. Appellants respectfully traverse these rejections for at least the reasons stated below.

1. By combining Hori with Wolf, the principle of operation of Hori would change.

If the proposed modification or combination of the prior art would change the principle of operation of the prior art invention being modified, then the teachings of the references are not sufficient to render the claims *prima facie* obvious. *In re Ratti*, 370 F.2d 810, 123 U.S.P.Q. 349 (C.C.P.A. 1959). Further, if the proposed modification would render the prior art invention being modified unsatisfactory for its intended purpose, then there is no suggestion or motivation to make the proposed modification. *In re Gordon*, 733 F.2d 900, 221 U.S.P.Q. 1125 (Fed. Cir. 1984). For the reasons discussed below, Appellants submit that by combining Hori with Wolf, the principle of operation in Hori would change and subsequently render the operation of Hori to perform its purpose unsatisfactorily.

Hori teaches forming sidewall spacers, spacers 5a and 5b, made of silicon nitride film. Column 6, lines 27 through 29. Hori further teaches that the exposed portions of a silicon oxide film, silicon oxide film 3, on the silicon substrate are removed so as to expose the silicon substrate thereunder. Column 6, lines 29-31. Hori further teaches that arsenic ions are implanted into the substrate using the gate electrode and sidewall spacers, spacers 5a and 5b, as a mask thereby forming an n^+-type source region and an n^+-type drain region. Column 6, lines 31-36. Hori further teaches depositing a titanium film with a thickness of 40 to 60 nanometers on the top

surface of the substrate. Column 6, lines 37 – 39. Hori further teaches a heat treatment at a temperature of 600° C to 850° C is conducted to allow the titanium film to react with the silicon substrate thereby forming titanium silicide films 8a, 8b, and 8c with a thickness of 60 to 100 nanometers, respectively. Column 6, lines 39-44. Hori further teaches that since the titanium film does not react with the silicon nitride film, the titanium films on the sidewall spacers, spacers 5a and 5b, remain unreacted. Column 6, lines 44 – 47. Hori further teaches that sidewall spacers, spacers 5a and 5b, are removed by a dry etching using an etching gas. Column 6, lines 50-52. Hori further teaches that boron ions are implanted using the gate electrode and the titanium silicide films 8a and 8b on the source and drain regions as a mask. Column 6, lines 53-56. Hori further teaches that p^+-type semiconductor regions 10a and 10b are formed as punch through stoppers. Column 6, lines 62-64. Hori further teaches that since the ion stopping power of titanium silicide is about 1.5 times higher than that of silicon, the boron ions are not allowed to permeate near pn-junctions between the n^+-type source and drain regions 7a and 7b and the substrate. Column 6, lines 64-68. Hori further teaches that as a result of the above-outlined process, p^+-type semiconductor regions 10a and 10b are formed only in a channel region. Column 6, line 68 – column 7, line 2. Hori further teaches that by not forming the p^+-type semiconductor regions 10a and 10b under the n^+ - type source and drain regions it is possible to obtain the high speed semiconductor transistor device with a small parasitic junction capacitance and a low impurity concentration in the center of the channel region. Column 7, lines 22-29.

Wolf, on the other hand, teaches that an appropriate mask layer needs to be present on the wafer surface to restrict the ionic species from being implanted into unwanted substrate regions. Page 321. Wolf further teaches that many materials are used for such masking purposes in IC fabrication including photoresist, SiO_2, Si_3N_4, polysilicon, metal films and polyimide. Page 321.

By combining Hori with Wolf, Hori would no longer be able to form the p^+-type semiconductor regions only in a channel region thereby not being able to obtain a high speed semiconductor transistor device with a small parasitic junction capacitance and a low impurity concentration in the center of the channel region. As stated above, Hori teaches using titanium silicide films 8a and 8b on the source and drain regions as a mask. Hori further teaches that since the <u>ion stopping power of titanium silicide is about 1.5 times higher than that of silicon</u>, <u>the boron ions are not allowed to permeate near pn-junctions between the n^+-type source and drain regions 7a and 7b and the substrate</u>. Wolf, on the other hand, teaches using a photoresist as a mask. The Examiner has not provided any evidence that would suggest that a photoresist, with the same thickness as titanium silicide, would have an ion stopping power similar to titanium silicide which is about 1.5 times higher than that of silicon. In fact, a photoresist has a much lower ion stopping power than titanium silicide and even lower than that of silicon. Appellants respectfully refer the Examiner to the periodic table of elements which indicates that silicon has an atomic number of 14, carbon has an atomic number of 6, and titanium has an atomic number of 81. The greater the number of the atomic number, i.e., the greater number of protons in the nucleus and the number of electrons orbiting the nucleus, the greater the ion stopping power. Since the atomic number of carbon, which a photoresist is mainly comprised of, is lower than the atomic number of silicon, one may conclude that the ion stopping power of a photoresist is less than that of silicon. Hence, by replacing titanium silicide with a photoresist of the same thickness, the ion stopping power will be less than that of silicon and hence not be able to prevent boron ions from permeating near pn–junctions between the n^+-type source and drain regions and the substrate. Hence, by combining Hori with Wolf, Hori would no longer be able to form p^+-type semiconductor regions only in a channel region thereby not being able to obtain a high speed semiconductor transistor device with a small parasitic junction capacitance and a low impurity concentration in the center of the channel region. Thus, by

combining Hori with Wolf, the principle of operation in Hori would change, and subsequently render the operation of Hori to perform its purpose unsatisfactorily. Therefore, the Examiner has not presented a *prima facie* case of obviousness for rejecting claims 1, 4-5, 7-8, 11-12 and 14. *In re Ratti*, 270 F.2d 810, 123 U.S.P.Q. 349 (C.C.P.A. 1959); *In re Gordon*, 733 F.2d 900, 221 U.S.P.Q. 1125 (Fed. Cir. 1984).

In response to Appellants' above argument, the Examiner asserts that both SiO_2 and photoresist have the ability to stop 99.99% of ionic species for a given thickness as illustrated in Figures 36(a) and (b) of Wolf. Paper No. 26, page 8. The Examiner further states that the comparison between SiO_2 and photoresist is not necessary. Paper No. 26, page 8.

Appellants respectfully disagree with the Examiner that the comparison is not necessary. The Examiner is combining Hori with Wolf in his rejection of claims 1, 4-5, 7-8, 11-12 and 14. The Examiner cannot combine Hori with Wolf if the principle of operation in Hori would change and subsequently render the operation of Hori to perform its purpose unsatisfactorily. By combining Hori with Wolf, titanium silicide films 8a and 8b on the source and drain regions in Hori would be replaced with photoresist. Hence, the comparison between SiO_2 and photoresist is necessary.

Further, Appellants direct the Examiner's attention to Figures 36(a) and (b) of Wolf which indicate that the thickness of photoresist must be greater than the thickness of silicon dioxide to stop the same percent of incident ions. Hori specifies that the titanium silicide films 8a and 8b have a thickness of 60 to 100nm. Column 6, lines 43-44. Hori further teaches that the boron ions are then implanted at a dose of 2 to $10X10^{12}$ cm^{-2} at 30 to 50 keV using titanium silicide films 8a and 8b as a mask. Column 6, lines 53-54. If a photoresist replaced titanium silicide films 8a and 8b with the same thickness, then boron ions are allowed to permeate near pn-junctions between the n^+-type source and drain regions 7a and 7b and the substrate (contrary to

the principle of operation of Hori). Hori specifically selected titanium silicide over silicon because of its better ion stopping power. As stated above, Hori selected titanium silicide in order to form the p+ -type semiconductor regions only in a channel region. Column 7, lines 1-2. Presumably, Hori could have used silicon instead of titanium silicide but with a greater thickness than 60 to 100nm (thickness of titanium silicide) in order to have the same ion stopping power as suggested by the Examiner. As stated above, the Examiner suggests that Hori could replace titanium silicide with photoresist but at an additional thickness in order to have the same ion stopping power. However, Hori did not substitute titanium silicide with silicon, in part, because of the additional thickness which would affect the implantation of the boron ions. Hori teaches that the boron ions are implanted into a substrate at such a large angle (an angle of ion beams to a normal line of a main surface of the substrate) as 20 to 60 degrees, preferably 25 to 45 degrees. Column 6, lines 56-61. By replacing titanium silicide with photoresist and consequently increasing the thickness of the mask, the angle at which the boron ions would have to be implanted into the substrate would have to be steeper than 25 to 45 degrees. For example, the angle would be less than 20 degrees (e.g., 10 degrees) or greater than 60 degrees (e.g., 80 degrees). This would change the principle of operation in Hori and subsequently render the operation of Hori to perform its purpose unsatisfactorily. Therefore, the Examiner has not presented a *prima facie* case of obviousness for rejecting claims 1, 4-5, 7-8, 11-12 and 14. *In re Ratti*, 270 F.2d 810, 123 U.S.P.Q. 349 (C.C.P.A. 1959); *In re Gordon*, 733 F.2d 900, 221 U.S.P.Q. 1125 (Fed. Cir. 1984).

2. Hori and Wolf, taken singly or in combination, do not teach or suggest the following claim limitations.

Appellants respectfully assert that Hori and Wolf, taken singly or in combination, do not teach or suggest "providing a thin photoresist layer" as recited in claim 1 and similarly in claim 8. The Examiner cites page 321 of Wolf as teaching the above-cited claim limitation. Paper No. 28, page 3. Appellants respectfully

traverse and assert that Wolf instead teaches using a photoresist as a mask layer to restrict the ionic species from being implanted into unwanted substrate regions. However, the language in the cited passage does not specifically state using a thin photoresist layer. Further, the Examiner has not provided any objective evidence for modifying Hori to provide a thin photoresist layer. The Examiner must provide objective evidence and not rely on his own subjective opinion in support of modifying Hori to provide a thin photoresist layer. *In re Lee*, 61 U.S.P.Q.2d 1430, 1434 (Fed. Cir. 2002). Therefore, the Examiner has not presented a *prima facie* case of obviousness, since the Examiner is relying upon an incorrect, factual predicate in support of the rejection. *In re Rouffet,* 47 U.S.P.Q.2d 1453, 1455 (Fed. Cir. 1998).

As a result of the foregoing, Appellants respectfully assert that there are numerous claim limitations not taught or suggested in the cited prior art, and thus the Examiner has not presented a *prima facie* case of obviousness for rejecting claims 1, 4-5, 7-8, 11-12 and 14 as being unpatentable over Hori in view of Wolf.

B. <u>Claims 7 and 14 are not properly rejected under 35 U.S.C. §103(a) as being unpatentable over Hori in view of Wolf and in further view of Thackeray.</u>

The Examiner has rejected claims 7 and 14 under 35 U.S.C. §103(a) as being unpatentable over Hori in view of Wolf and in further view of Thackeray. Paper No. 28, page 4. Appellants respectfully traverse these rejections for at least the reason that the combination of Hori with Wolf would change the principle of operation as discussed above on pages 5-9 and that Hori and Wolf, taken singly or in combination, do not teach or suggest all of the limitations in claims 1 and 8 as discussed above on pages 9-10. Appellants also respectfully traverse these rejections for at least the reasons stated below.

As stated above, if the proposed modification or combination of the prior art would change the principle of operation of the prior art invention being modified,

then the teachings of the references are not sufficient to render the claims *prima facie* obvious. *In re Ratti*, 370 F.2d 810, 123 U.S.P.Q. 349 (C.C.P.A. 1959). Further, if the proposed modification would render the prior art invention being modified unsatisfactory for its intended purpose, then there is no suggestion or motivation to make the proposed modification. *In re Gordon*, 733 F.2d 900, 221 U.S.P.Q. 1125 (Fed. Cir. 1984). For the reasons discussed below, Appellants submit that by combining Hori with Thackeray, the principle of operation in Hori would change and subsequently render the operation of Hori to perform its purpose unsatisfactorily.

As stated above, Hori teaches forming sidewall spacers, spacers 5a and 5b, made of silicon nitride film. Column 6, lines 27 through 29. Hori further teaches that the exposed portions of a silicon oxide film, silicon oxide film 3, on the silicon substrate are removed so as to expose the silicon substrate thereunder. Column 6, lines 29-31. Hori further teaches that arsenic ions are implanted into the substrate using the gate electrode and sidewall spacers, spacers 5a and 5b, as a mask thereby forming an n^+-type source region and an n^+-type drain region. Column 6, lines 31-36. Hori further teaches depositing a titanium film with a thickness of 40 to 60 nanometers on the top surface of the substrate. Column 6, lines 37 – 39. Hori further teaches a heat treatment at a temperature of 600° C to 850° C is conducted to allow the titanium film to react with the silicon substrate thereby forming titanium silicide films 8a, 8b, and 8c with a thickness of 60 to 100 nanometers, respectively. Column 6, lines 39-44. Hori further teaches that since the titanium film does not react with the silicon nitride film, the titanium films on the sidewall spacers, spacers 5a and 5b, remain unreacted. Column 6, lines 44 – 47. Hori further teaches that sidewall spacers, spacers 5a and 5b, are removed by a dry etching using an etching gas. Column 6, lines 50-52. Hori further teaches that boron ions are implanted using the gate electrode and the titanium silicide films 8a and 8b on the source and drain regions as a mask. Column 6, lines 53-56. Hori further teaches that p^+-type

semiconductor regions 10a and 10b are formed as punch through stoppers. Column 6, lines 62-64. Hori further teaches that since the ion stopping power of titanium silicide is about 1.5 times higher than that of silicon, the boron ions are not allowed to permeate near pn-junctions between the n^+-type source and drain regions 7a and 7b and the substrate. Column 6, lines 64-68. Hori further teaches that as a result of the above-outlined process, p^+-type semiconductor regions 10a and 10b are formed only in a channel region. Column 6, line 68 – column 7, line 2. Hori further teaches that by not forming the p^+-type semiconductor regions 10a and 10b under the n^+ - type source and drain regions it is possible to obtain the high speed semiconductor transistor device with a small parasitic junction capacitance and a low impurity concentration in the center of the channel region. Column 7, lines 22-29.

Thackeray, on the other hand, teaches a photoresist composition comprising a resin binder having acid labile blocking groups requiring an activation energy in excess of 20 Kcal/mol. for deblocking, a photoacid generator capable of generating a halogenated sulfonic acid upon photolysis and optionally a base additive. Abstract.

By combining Hori with Thackeray, Hori would no longer be able to form the p^+-type semiconductor regions only in a channel region thereby not being able to obtain a high speed semiconductor transistor device with a small parasitic junction capacitance and a low impurity concentration in the center of the channel region. As stated above, Hori teaches using titanium silicide films 8a and 8b on the source and drain regions as a mask. Hori further teaches that since the ion stopping power of titanium silicide is about 1.5 times higher than that of silicon, the boron ions are not allowed to permeate near pn-junctions between the n^+-type source and drain regions 7a and 7b and the substrate. Thackeray, on the other hand, teaches a photoresist composition. The Examiner has not provided any evidence that would suggest that a photoresist, with the same thickness as titanium silicide, would have an ion stopping power similar to titanium silicide which is about 1.5 times higher than that of silicon.

In fact, a photoresist has a much lower ion stopping power than titanium silicide and even lower than that of silicon. Appellants respectfully refer the Examiner to the periodic table of elements which indicates that silicon has an atomic number of 14, carbon has an atomic number of 6, and titanium has an atomic number of 81. The greater the number of the atomic number, i.e., the greater number of protons in the nucleus and the number of electrons orbiting the nucleus, the greater the ion stopping power. Since the atomic number of carbon, which a photoresist is mainly comprised of, is lower than the atomic number of silicon, one may conclude that the ion stopping power of a photoresist is less than that of silicon. Hence, by replacing titanium silicide with a photoresist of the same thickness, the ion stopping power will be less than that of silicon and hence not be able to prevent boron ions from permeating near pn–junctions between the n^+-type source and drain regions and the substrate. Hence, by combining Hori with Thackeray, Hori would no longer be able to form p^+-type semiconductor regions only in a channel region thereby not being able to obtain a high speed semiconductor transistor device with a small parasitic junction capacitance and a low impurity concentration in the center of the channel region. Thus, by combining Hori with Thackeray, the principle of operation in Hori would change, and subsequently render the operation of Hori to perform its purpose unsatisfactorily. Therefore, the Examiner has not presented a *prima facie* case of obviousness for rejecting claims 7 and 14. *In re Ratti*, 270 F.2d 810, 123 U.S.P.Q. 349 (C.C.P.A. 1959); *In re Gordon*, 733 F.2d 900, 221 U.S.P.Q. 1125 (Fed. Cir. 1984).

Further, as stated above, Appellants direct the Examiner's attention to Figures 36(a) and (b) of Wolf which indicate that the thickness of photoresist must be greater than the thickness of silicon dioxide to stop the same percent of incident ions. Hori specifies that the titanium silicide films 8a and 8b have a thickness of 60 to 100nm. Column 6, lines 43-44. Hori further teaches that the boron ions are then implanted at a dose of 2 to $10X10^{12}$ cm^{-2} at 30 to 50 keV using titanium silicide films 8a and 8b as

a mask. Column 6, lines 53-54. If a photoresist replaced titanium silicide films 8a and 8b with the same thickness, then boron ions are allowed to permeate near pn-junctions between the n^+-type source and drain regions 7a and 7b and the substrate (contrary to the principle of operation of Hori). Hori specifically selected titanium silicide over silicon because of its better ion stopping power. As stated above, Hori selected titanium silicide in order to form the p+ -type semiconductor regions only in a channel region. Column 7, lines 1-2. Presumably, Hori could have used silicon instead of titanium silicide but with a greater thickness than 60 to 100nm (thickness of titanium silicide) in order to have the same ion stopping power as suggested by the Examiner. As stated above, the Examiner suggests that Hori could replace titanium silicide with photoresist but at an additional thickness in order to have the same ion stopping power. However, Hori did not substitute titanium silicide with silicon, in part, because of the additional thickness which would affect the implantation of the boron ions. Hori teaches that the boron ions are implanted into a substrate at such a large angle (an angle of ion beams to a normal line of a main surface of the substrate) as 20 to 60 degrees, preferably 25 to 45 degrees. Column 6, lines 56-61. By replacing titanium silicide with photoresist and consequently increasing the thickness of the mask, the angle at which the boron ions would have to be implanted into the substrate would have to be steeper than 25 to 45 degrees. For example, the angle would be less than 20 degrees (e.g., 10 degrees) or greater than 60 degrees (e.g., 80 degrees). This would change the principle of operation in Hori and subsequently render the operation of Hori to perform its purpose unsatisfactorily. Therefore, the Examiner has not presented a *prima facie* case of obviousness for rejecting claims 7 and 14. *In re Ratti*, 270 F.2d 810, 123 U.S.P.Q. 349 (C.C.P.A. 1959); *In re Gordon*, 733 F.2d 900, 221 U.S.P.Q. 1125 (Fed. Cir. 1984).

As a result of the foregoing, Appellants respectfully assert that the Examiner has not presented a *prima facie* case of obviousness for rejecting claims 7 and 14 as

being unpatentable over Hori in view of Wolf and in further view of Thackeray. M.P.E.P. §2143.

C. Claims 18-19 are not properly rejected under 35 U.S.C. §103(a) as being unpatentable over Rodder.

The Examiner has rejected claims 18-19 under 35 U.S.C. §103(a) as being unpatentable over Rodder. Paper No. 28, page 4. Appellants respectfully traverse these rejections for at least the reasons stated below.

Appellants respectfully assert that Rodder does not teach or suggest "a photoresist layer of a thickness between .1 μm to .2 μm over said oxide trench and a substantial portion of said source and said drain region, wherein a halo implant is implanted using said photoresist layer and said gate as a mask" as recited in claim 18. The Examiner cites element 30 of Rodder as teaching the above-cited claim limitation. Paper No. 28, page 5. Appellants respectfully traverse and assert that Rodder teaches that masking layer 30 is formed over the semiconductor layer 12 and expose a first section 32 and a second section 34 of the active area 20 as illustrated in Figure 1B. There is no source region (Examiner asserts that region 92 corresponds to a source region) or drain region (Examiner asserts that region 96 corresponds to a drain region) illustrated in Figure 1B. Instead, masking layer 30 is coated, patterned and etched to expose the first and second sections 32 and 34 of the active area 20. Column 4, lines 55-57. Later, source and drain main bodies 88 and 90 are formed as illustrated in Figure 1E. Column 7, lines 30-32. Accordingly, masking layer 30 is not placed over a substantial portion of a source and a drain region. Therefore, the Examiner has not presented a *prima facie* case of obviousness, since the Examiner is relying upon an incorrect, factual predicate in support of the rejection. *In re Rouffet*, 47 U.S.P.Q.2d 1453, 1455 (Fed. Cir. 1998).

Further, in connection with the rejection of the above-cited claim limitation, the Examiner acknowledges that Rodder teaches that masking layer has a thickness of

0.3 to 1.3 μm (column 6, lines 7-8) which is out of the range of Appellants' claim language (Appellants claim a photoresist layer with a thickness between .1 μm to .2 μm). Paper No. 28, page 5. The Examiner states:

> It would have been obvious to one of ordinary skill in the art to include a photoresist of a thickness between .1 μm to .2 μm, since it has been held that where the general conditions of a claim are disclosed in the prior art, discovering the optimum or working ranges involves only routine skill in the art. *In re Huang*, 40 U.S.P.Q.2d 1685, 1688 (Fed. Cir. 1996) citing *In re Aller*, 105 U.S.P.Q. 233, 235 (C.C.P.A. 1955). The motivation for controlling the thickness of the photoresist in the manner described above is reducing the shadowing effect during the implantation process. Paper No. 28, page 5.

Appellants respectfully traverse that it would have been obvious to one of ordinary skill in the art to modify masking layer 30 in Rodder to have a thickness between .1 μm to .2 μm. Appellants respectfully point out that Rodder never disclosed the general conditions of a claim as asserted by the Examiner. Appellants have shown in the Specification that using a photoresist layer with a thickness between .1 μm to .2 μm is critical. There is no language in Rodder that suggests to modify masking layer to have a critical thickness between .1 μm to .2 μm. In fact, Rodder specifically teaches that masking layer 30 has a thickness between 0.3 to 1.3 μm. Column 6, lines 7-8. Hence, since the general conditions of claim 18 were not disclosed by Rodder, the Examiner's reliance upon *In re Huang* and *In re Aller* is misguided.

Further, Appellants note that *In re Aller*, upon which the Examine relies, precedes *Graham v. John Deere Co.*, 383 U.S. 1, 148 U.S.P.Q. 459 (1966). Accordingly, the holdings of *Graham* may overrule the holdings in *In re Aller*.

Further, the Examiner must provide extrinsic evidence that must make clear that modifying masking layer 30 to have a smaller thickness between .1 μm to .2 μm

reduces the shadowing effect during the implantation process[1] (Examiner's motivation). *Ex parte Levy*, 17 U.S.P.Q.2d 1461, 1464 (Bd. Pat. App. & Inter. 1990). That is, the Examiner must provide extrinsic evidence that must make clear that modifying masking layer 30 to have a smaller thickness between .1 μm to .2 μm reduces the shadowing effect during the implantation process, and that it be so recognized for persons of ordinary skill. *In re Robertson*, 169 F.3d 743, 745 (Fed. Cir. 1999). The Examiner has not provided any objective evidence to support the assertion that modifying masking layer 30 to have a smaller thickness between .1 μm to .2 μm reduces the shadowing effect during the implantation process, and therefore the Examiner has not presented a *prima facie* case of obviousness for rejecting claims 18-20. M.P.E.P. §2143.

Appellants further assert that Rodder does not teach or suggest "wherein said halo implant is implanted at a substantially 45 degree angle" as recited in claim 19. The Examiner cites column 12, lines 38-39 of Rodder which teaches an implant angle between 7-30 degrees. Paper No. 28, page 5. The Examiner further states that:

> It would have been obvious to one of ordinary skill in the art to include an implant angle of 45 degrees, since it has been held that where the general conditions of a claim are disclosed in the prior art, discovering the optimum or working ranges involves only routine skill in the art. *In re Huang*, 40 U.S.P.Q.2d 1685, 1688 (Fed. Cir. 1996) citing *In re Aller*, 105 U.S.P.Q. 233, 235 (C.C.P.A. 1955). The motivation for adjusting the implant angle in the manner described above is forming halo region of a desired size and depth that greatly reduce capacitance of the transistor (col. 12, lines 41-44 of Rodder). Paper No. 28, pages 5-6.

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[1] As understood by Appellants, in order to reduce the shadowing effect, the thickness of masking layer 30 would have to be relatively thick, e.g., greater than 1.3 μm, in order for dopants to be implanted from a direction substantially parallel to the gate electrode 22 to produce ultrashallow extensions 52, 54. The masking layer 30 may block the entry of the dopants from non-parallel directions to the gate electrode 22 into the exposed sections 32 and 34 of the active area. See column 6, lines 12-20 of Rodder.

Appellants respectfully traverse that it would have been obvious to modify Rodder to implant at a substantially 45 degree angle to form pockets 70 and 72. Appellants respectfully point out that Rodder never disclosed the general conditions of a claim as asserted by the Examiner. Rodder teaches implanting between 7-30 degrees. Further, there is no language in Rodder that suggests implanting at a substantially 45 degree angle to form pockets 70 and 72. In fact, Rodder specifically teaches implanting between 7-30 degrees to form pockets 70 and 72. Column 12, lines 38-39. Hence, since the general conditions of claim 19 were not disclosed by Rodder, the Examiner's reliance upon *In re Huang* and *In re Aller* is misguided.

Further, Appellants note that *In re Aller*, upon which the Examiner relies, precedes *Graham v. John Deere Co.*, 383 U.S. 1, 148 U.S.P.Q. 459 (1966). Accordingly, the holdings of *Graham* may overrule the holdings in *In re Aller*.

Further, the Examiner must provide extrinsic evidence that must make clear that modifying the implant angle to be a substantially 45 degree angle forms a halo region of a desired size and depth that greatly reduce capacitance of the transistor (Examiner's motivation). *Ex parte Levy*, 17 U.S.P.Q.2d 1461, 1464 (Bd. Pat. App. & Inter. 1990). That is, the Examiner must provide extrinsic evidence that must make clear that modifying the implant angle to be a substantially 45 degree angle forms a halo region of a desired size and depth that greatly reduce capacitance of the transistor, and that it be so recognized for persons of ordinary skill. *In re Robertson*, 169 F.3d 743, 745 (Fed. Cir. 1999). The Examiner has not provided any objective evidence to support the assertion that modifying the implant angle to be a substantially 45 degree angle forms a halo region of a desired size and depth that greatly reduce capacitance of the transistor, and therefore the Examiner has not presented a *prima facie* case of obviousness for rejecting claim 19. M.P.E.P. §2143.

As a result of the foregoing, Appellants respectfully assert that there are numerous claim limitations not taught or suggested in the cited prior art, and thus the

Examiner has not presented a *prima facie* case of obviousness for rejecting claims 18-19 as being unpatentable over Rodder. M.P.E.P. §2143.

D. Claim 20 is not properly rejected under 35 U.S.C. §103(a) as being unpatentable over Rodder in view of Thackeray.

The Examiner has rejected claim 20 under 35 U.S.C. §103(a) as being unpatentable over Rodder and in view of Thackeray. Paper No. 28, page 6. Appellants respectfully traverse these rejections for at least the reasons stated below.

A *prima facie* showing of obviousness requires the Examiner to establish, *inter alia*, that the prior art references teach or suggest, either alone or in combination, all of the limitations of the claimed invention, and the Examiner must provide a motivation or suggestion to combine or modify the prior art reference to make the claimed inventions. M.P.E.P. § 2142. The showings must be clear and particular and supported by objective evidence. *In re Lee*, 277 F.3d 1338, 1343, 61 U.S.P.Q.2d 1430, 1433-34 (Fed. Cir. 2002); *In re Kotzab*, 217 F.3d 1365, 1370, 55 U.S.P.Q.2d 1313, 1317 (Fed. Cir. 2000); *In re Dembiczak*, 50 U.S.P.Q.2d. 1614, 1617 (Fed. Cir. 1999). Broad conclusory statements regarding the teaching of multiple references, standing alone, are not evidence. *Id.*

The Examiner's motivation for modifying Rodder with Thackeray to have a photoresist layer that comprises a deep ultraviolet layer, as recited in claim 20, is "to effectively activate the photoactive component of the photoresist system (see col. 12, lines 60-62 and col. 13, lines 1-6)." Paper No. 28, page 6. This motivation is insufficient to support a *prima facie* case of obviousness as discussed below.

The Examiner's motivation appears to have been gleaned from the secondary reference (Thackeray). In fact, the Examiner cites column 12, lines 60-62 and column 13, lines 1-6 of Thackeray as support for his motivation. Paper No. 28, page 6. This is not evidence as to why one of ordinary skill in the art with the primary

reference (Rodder) in front of him would have been motivated to modify the primary reference (Rodder) with the teachings of the secondary reference (Thackeray). The Examiner's motivation is a motivation for the secondary reference (Thackeray) to solve its problem. This is not a suggestion to combine the primary reference (Rodder) with the secondary reference (Thackeray). The Examiner must provide objective evidence as to why one of ordinary skill in the art with the primary reference (Rodder) in front of him, which teaches a method for forming a transistor having localized source and drain extensions (column 1, lines 3-6 of Rodder), would have been motivated to modify the primary reference (Rodder) with the teachings of the secondary reference (Thackeray), which teaches photoresist compositions comprising a resin binder having acid labile blocking groups requiring an activation energy in excess of 20 Kcal/mol. for deblocking, a photoacid generator capable of generating a halogenated sulfonic acid upon photolysis and optionally, a base additive (Abstract of Thackeray). *See In re Lee*, 61 U.S.P.Q.2d 1430, 1433-1434 (Fed. Cir. 2002); *In re Kotzab*, 55 U.S.P.Q.2d 1313, 1318 (Fed. Cir. 2000). Merely stating what the secondary reference teaches is <u>not</u> evidence for combining a primary reference (Rodder) with the secondary reference (Thackeray). *See Id.* Consequently, the Examiner's motivation is insufficient to support a *prima facie* case of obviousness for rejecting claim 20. *In re Lee*, 61 U.S.P.Q.2d 1430, 1434 (Fed. Cir. 2002).

Further, the Examiner must submit objective evidence and not rely on his own subjective opinion in support of combining Rodder, which teaches a method for forming a transistor having localized source and drain extensions, with Thackeray, which teaches photoresist compositions comprising a resin binder having acid labile blocking groups requiring an activation energy in excess of 20 Kcal/mol. for deblocking, a photoacid generator capable of generating a halogenated sulfonic acid upon photolysis and optionally, a base additive. *Id.* There is no suggestion in Rodder to use a photoresist composition comprising a resin binder having acid labile blocking groups requiring an activation energy in excess of 20 Kcal/mol. for deblocking.

Neither is there any suggestion in Rodder to use a photoresist composition comprising a photoacid generator capable of generating a halogenated sulfonic acid upon photolysis. Neither is there any suggestion in Rodder to use a photoresist composition comprising a base additive. Since the Examiner has not submitted objective evidence for modifying Rodder with Thackeray, the Examiner has not presented a *prima facie* case of obviousness for rejecting claim 20.

Further, the Examiner must submit objective evidence and not rely on his own subjective opinion in support of modifying Rodder to have a photoresist layer that comprises a deep ultraviolet layer (Examiner admits that Rodder does not teach this limitation). *Id.* There is no suggestion in Rodder of having a semiconductor device with a photoresist layer that comprises a deep ultraviolet layer. Since the Examiner has not submitted objective evidence for modifying Rodder to have a photoresist layer that comprises a deep ultraviolet layer, the Examiner has not presented a *prima facie* case of obviousness for rejecting claim 20. *Id.*

As a result of the foregoing, Appellants respectfully assert that the Examiner has not presented a *prima facie* case of obviousness for rejecting claim 20. M.P.E.P. §2143.

IX. CONCLUSION

For the reasons noted above, the rejections of claims 1, 4-5, 7-8, 11-12, 14 and 18-20 are in error. Appellants respectfully request reversal of the rejections and allowance of claims 1, 4-5, 7-8, 11-12 and 14-20.

Respectfully submitted,

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APPENDIX

1. A method for providing a halo implant to a semiconductor device comprising the steps of:

(a) providing a thin photoresist layer to the semiconductor device that covers a substantial amount of an active area comprising a source region and a drain region of the semiconductor device; and

(b) providing the halo implant to the semiconductor device, wherein the thin photoresist layer is used as a mask.

4. The method as recited in claim 1 wherein the halo implant is at approximately 45° angle.

5. The method of claim 1 which includes the step of providing a lightly doped drain implant before the halo implant providing step (b).

7. The method of claim 1 wherein the photoresist layer comprises a deep ultraviolet (DUV) layer.

8. A system for providing a halo implant to a semiconductor device comprising:

means for providing a think photoresist layer to the semiconductor device, wherein the thin photoresist layer covers a substantial amount of an active area comprising a source region and a drain region of the semiconductor device; and

means for providing the halo implant to the semiconductor device, wherein the thin photoresist layer is used as a mask.

11. The system as recited in claim 8 wherein the halo implant is at approximately 45° angle.

12. The system of claim 8 which includes the step of providing a lightly doped drain implant before the halo implant providing step (b).

14. The system of claim 8 wherein the photoresist layer comprises a deep ultraviolet (DUV) layer.

15. A method for implanting a halo implant in a semiconductor device comprising the steps of:

providing a first photoresist layer of a thickness 0.55 μm or greater over an oxide trench of said semiconductor device;

providing a lightly doped drain implant;

removing said first photoresist layer;

providing a second photoresist layer of a thickness between .1 μm to .2 μm over said oxide trench and a substantial portion of a source and a drain region; and

implanting a halo implant using said second photoresist layer as a mask.

16. The method as recited in claim 15, wherein said halo implant is implanted at a substantially 45 degree angle.

17. The method as recited in claim 15, wherein said second photoresist layer comprises a deep ultraviolet layer.

18. A semiconductor device, comprising:

a gate;

an oxide trench;

a drain region adjacent to said oxide trench;

a source region adjacent to said oxide trench; and

a photoresist layer of a thickness between .1 μm to .2 μm over said oxide trench and a substantial portion of said source and said drain region, wherein a halo implant is implanted using said photoresist layer and said gate as a mask.

19. The semiconductor device as recited in claim 18, wherein said halo implant is implanted at a substantially 45 degree angle.

20. The semiconductor device as recited in claim 18, wherein said photoresist layer comprises a deep ultraviolet layer.

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